Book Reviews.

DIE LEITUNGSBAHNEN IM GEHIRN UND RUCKENMARK [*The Conducting Pathways in the Brain and Spinal Cord*]. Von W. von Bechterew, mit 16 textabbildungen und einer lithographischen tafel. 210 pages. Leipzig, published by Edward Besold. 1894.

The author of this book is known to neurologists as one of the most industrious investigators of the anatomy of the nervous system of the present day. During the past few years contributions from his laboratory and from his pen have appeared in various Russian and German journals, and this book is apparently the endeavor to place before the profession in a connected form these various contributions. The book is contained in five chapters. The first chapter is taken up with some remarks on the method of investigating the course of fibres in the central nervous system. Chapter II., the fibres of the spinal cord. Chapter III., the fibres of the crura cerebri. Chapter IV., the fibres of the cerebellum, and Chapter V., the fibres of the cerebral hemispheres. To the book is appended an exhaustive and valuable reference to the literature of the subject referred to in the text.

In discussing the methods that have been of service in revealing the secrets of construction of the nervous system, the author has given some attention to each one; he has laid particular stress, however, upon the embryological method, the one by which most of his results have been obtained. The method of comparative anatomy, the one by which Edinger has done so much valuable work, is somewhat neglected. We also miss special mention of the method employed by Marchi and Alzer ; for although this can be grouped under the method of secondary degenerations, it has characteristics which justify its being placed in a category of its own. Although the embryological method is mostly favored, the author admits that for defining the longitudinal extent of systems of fibres in the spinal cord, it is less accurate and less satisfactory than the method of secondary degeneration ; he ranks it first, however, for separating each single fasiculus from the surrounding parts.

Of the method of atrophy (Gudden's) he says that it is exact only so far as it gives definite results, but not when the results are negative ; that is, if after destruction of a certain part, another part becomes atrophic, we can conclude with certainty these parts are connected with each other ; but if for any reason the destruction of one part is not followed by atrophy in another part, which latter we have been led to believe from investigations by other methods is connected with the first, it would be wrong to conclude that the said two parts have any mutual relation. The author does not do Gudden's method justice by this general statement. It is necessary to explain more in detail by what principles Gudden's method is governed. Forel has clearly shown that the intensity of the atrophy depends upon the relation of the destroyed portion to the neuron, of which it forms a part. If it were an essential part of this neuron, for instance the chief axis cylinder of a cell of Golgi's first category, an intense atrophy of the ganglion cell from which the axis cylinder originated would follow. If, however, the destroyed part was but a collateral of an axis cylinder, or if it was the central part of a fibre which terminates in a network in the near neighborhood, we would find only slight atrophy of the cell in the first case and usually only an atrophy of the said network in the second. As Forel explains in his last monograph (Ueber das Verthaltniss der experimentellen Atrophie und Degenerations methode zur Anatomie und Histologie des Centralnervensystems, Zurich, 1891), an accurate knowledge of the anatomical and physiological relations of the different parts can only be obtained by the use of all methods in such a way that the results acquired by one are completed, confirmed, and controlled by the others. This statement is also pertinent to findings by the embryological method. One cannot deny the great advantages of the latter, first, that it directly concerns the relations of the human nervous system, and second, that with less material and less work it gives a wider range of study than any other method, as it offers a mosaic-like differentiation not only of a single tract in different regions, but more or less in all the tracts in all parts of the nervous system simultaneously. Great as are these advantages the disadvantages must not be ignored. One of them is that the development of the myelin is rather irregular, so that one part of a nerve fibre may be medullated at a certain time, the other not; or one part may be surrounded with a thick medullary sheath while the myelin sheath of another part is still very thin, consequently the nerve fibre will appear coarsely club-shaped in one transverse section and finely club-shaped in another, while in a third section the conditions may be reversed again. The confusion liable to follow is evident. If it is a fact, as claimed by others, that hæmatoxylin stains not alone medullated but also non-medullated fibres, another disadvantage arises when hæmatoxylin staining is used, which Bechterew frequently does.

It cannot be denied that the embryological method can give us information as to the connection of individual fibres with ganglionic cells. Even with the comparative method of progressive serial sections this is sometimes possible, as, for instance, frequently the axis cylinder of a cell of the anterior roots can be seen passing, after covering itself with a myelin sheath, out as an anterior root fibre.

With the embryological method it is still much easier to follow the course of a nerve fibre, and prove its connection with a certain cell, since the confusion caused by the interlacing of fibres coming in various directions is lessened by the circumstance that part of them (medullated) differ in their appearance from the others (non-medullated). But such conditions are rather rare and those that have been cited are comparatively plain.

The method of atrophy and secondary degeneration have the great advantage over the others that they offer an isolation, not only of bundles or tracts of fibres, but also the cells with which they have connection. This isolation, it is true, is often negative, which is a disadvantage, because it makes it very difficult, for instance, to prove partial crossed connection with a certain group; a complete disappearance of a small number of cells of a certain group could only be stated when all the cells of the group are counted and their number compared with that of a similar group in a normal cord. In this case one would have to be sure that no section of a continuous series of sections was absent, and that the sections were of an even thickness; yet it must be said, when the methods of atrophy and secondary degeneration give distinct positive results, they are more reliable than results obtained by the embryologic method.

Bechterew states that the development of the various systems of fibres doubtless depends upon the development of the central apparatus in which they end, and for this reason the method allows us to draw other conclusions; such, for instance, as to the development of certain cerebral centres. This statement which, besides being too general, gives no exact idea in what it consists, and must be accepted with due reserve, particularly if it has reference also to spinal centres.

In the second chapter the author first describes the course of the fibres of the spinal nerves. Based upon the non-simultaneous development of the medullary sheaths two fasiculi of the posterior root are distinguished, the medial, consisting chiefly of coarse fibres, which, after entering the spinal cord, become partly portions of Burdach's and portions of Goll's columns, and the lateral, consisting almost exclusively of fine fibres which are more or less identical with Lissauer's column. The fibres of the lateral fasiculus have altogether different connections with the gray substance than the medial.

The fibres of the medial fasiculus take the following course:

A part becomes connected with Goll's column; a part enters into the gray substance of the posterior horn, where they disappear at about the middle portion of the gray substance in the neighborhood of the cells situated there, and a part reaches the base of the anterior horns, where they disappear into a meshwork situated between the large cells of the anterior horns, while others still pass through the anterior commissure into the anterior horn of the opposite side.

The fibres of the lateral bundles of the posterior columns become connected with the substantia gelatinosa Rolandi, with the cells of the posterior horn generally, and especially with that group of cells situated nearest the substantia gelatinosa; also with the cell groups situated between the lateral and posterior horns (lateral group of the posterior horn of Bechterew), and, lastly, through the posterior commissure with the gray matter of the other side.

B. discusses Sanger's and Munzer's conclusions on the course of the posterior roots, and admits that part of the fibres of Goll's column are a direct continuation of fibres of the posterior root, but concludes, from observations made by the embryological method, that part of them originate from the gray substance of the cord. He thinks that a direct connection of posterior root fibres (or of collaterals of these) with the nuclei Gracilis et Cuneati is not proven by Sanger's and Munzer's experiments.

In the outer roots he makes a systematic distinction between coarse and fine fibres, as the coarse fibres receive their medullary sheaths at a different period from the fine ones. The coarse fibres originate from the cells of the anterior horn of the same side and part of them also through the anterior commissure from analogous cells of the other side. The fine fibres take their origin from the cells of the lateral horn, from the tractus intermedio-lateralis, from the solitary cells of the posterior horn, and also from the cell group, which is situated at the anterior border of the substantia gelatinosa Rolandi.

Bechterew inclines to the view that the functions of the fine fibres of the anterior roots differ from those of the coarse fibres. He cites the theory of Gaskell and Mott, apparently with approbation, that the coarse fibres probably are destined for the innervation of striped muscular fibre, while the fine ones probably enter the sympathetic system, and are destined for the innervation of the internal organs.

The author classes the accessorious with the spinal nerve, and says that the cephald portion is actually part of the pneumogastric nerve. He denies a connection of the accessiorius with the nucleus ambiguus and with the solitary fasiculus of the medulla.

The following secondary connections of the various cell groups are assumed by B.:

First. For Clark's columns with the direct cerebellar bundles, with Burdach's and partly with Goll's columns, and through the anterior commissure with cells of the anterior horn of the other side.

Second. From the cells of the central group of the gray substance many fibres pass into the lateral columns, while others enter the anterior commissure.

Third. From the cells which are situated at the anterior border of the substantia gelatinosa Rolandi, and which B. considers to be the most important terminal station of the fibres of the lateral fasiculus of the posterior roots, through the anterior and partly through the posterior to the lateral columns of the other side and to Burdach's and Goll's column.

He cites Ramony Cajal's observation concerning the division of the posterior root fibre into ascending and descending fasiculi, the collaterals of these branches, etc. The ascending systems of fibres originate from the chief axis cylinders of cells of the gray substance (for instance the direct cerebellar fasiculus); those of the descending systems (first pyramid) end with terminal branches in close neighborhood to the cells of the white substance.

B.'s description of the coarse fibres of the white substance of the cord is chiefly based upon results obtained by the embryologic method and that of secondary degeneration.

First. Burdach's column. In the grouping of its fibres B. accepts Flechsig's division of three zones. He thinks that besides direct posterior root fibres Burdach's column contains a system of short fibres which connect different levels of the gray substance of the posterior horns.

Second. Goll's column. The results of the embryologic method justify the division of a median, lateral and intermediary zone. The median zone contains fibres which are the direct continuation of the fibres of the posterior root.

Third. The antero-lateral columns. He distinguishes six tracts. First, the lower pyramidal tracts; second, the direct cerebellar tracts; third, the medial fasiculus of the antero-lateral column; fourth, the antero-lateral or antero-external fasiculus (Gower's tract); fifth, the ground bundle of the antero-lateral column, and, sixth, the anterior pyramidal tract.

The median fasiculi of the antero-lateral columns have been discovered by the embryologic method. It forms that part of the border of the gray substance which is situated next to the lateral border of the gray substance. Of the origin of that fasiculus nothing positive is known. In opposition to Lowenthal, Bechterew emphasizes that the direct cerebellar fibres originate from Clarke's column. They are connected with the cerebellum through the Restiform body.

The fibres of the antero-lateral fasiculus can be traced into the anterior conducting paths of the medulla, where they probably become interrupted.

The author cites the interesting observations of Barcacci, that lesion of the cord at the level of the twelfth vertebra caused ascending degeneration of Gower's tract, and left the direct cerebellar fasiculi normal, but that lesion at the level of the sixth dorsal vertebra caused ascending degeneration of Gower's tract and of the direct cerebellar fasiculi. The area of the lateral pyramidal tracts, as shown by the embryologic method, shows much larger than when isolated by the method of secondary degeneration. B. contends, therefore, that the former must contain fibres of other systems besides those of the pyramids.

The third chapter, which is taken up with a description of the course of nerve fibres in the cerebral stems, begins with a description of the various nuclei and nests of gray matter situated in the peduncles.

He mentions a nucleus situated at the level of the nucleus of the lateral fillet in the central part of the formatio reticularis. This nucleus, which B. thinks has not been described before, he proposes to call nucleus centralis superior and centralis, and for purposes of distinction he proposes to call the superior central nucleus, nucleus centralis superior medialis. In speaking of the functions of the various nests of gray substance situated in the cerebral stems, he says that based upon experiments performed by him he must describe equilibratory functions to certain parts that are situated near the third ventricle, and which have not yet been sufficiently investigated anatomically. The nuclei of the pons has relation to the maintenance of the equilibrium. According to Misslawsky's experiments the nucleus of the anterior column must be a respiratory centre. The lowest central nucleus corresponds closely to the location of the vaso-motor centre. This justifies the statement that the fasiculi of this centre is perforated by said nucleus. The nucleus reticularis, most probably, is a particular motor centre.

B. says that the superior olivary bodies being in connection with the nucleus of the acusticus (nucleus anterior Meynert's), we must ascribe to them the functions of a centre governing the reflectory movements of the eye. He does not doubt that the corpora bigemino posterior besides having auditory functions, have the significance of a special motor or coördinating centre. The nuclei of the optic thalamus have chiefly motor functions, governing especially the involuntary movements of internal organs, heart, stomach, etc., and those involuntary movements which are the expression of sensations or psychical reflex.

B. then describes the course of the fibres of the cerebral nerves. In opposition to Lauras, he denies the relation of the twelfth nerve to the nucleus ambiguus ; also to the inferior olivary bodies. This in opposition to the opinion of Forel and of Mayser. He reiterates the assertion that the pneumogastric is connected with the nucleus ambiguus of both sides, although Mayser, and more recently Koch, denies this connection. The author has discovered a new neucleus situated near the bottom of the Calamus Scriptorius, latterly from the nucleus of the ninth nerve. He is sure that this newly discovered nucleus is also connected with the ninth nerve. B. still maintains that the anterior root of the eighth nerve is connected with the lateral or Deiter's nucleus, and says that investigations with Golgi's method by Sala, who denies these connections, are not reliable or convincing. Part of the fibres of the seventh nerve originate from the nucleus of the other side. He thinks that a connection of sixth nucleus with the third nucleus of the other side has yet to be proven. The cells of the substantia ferruginea probably have relations with the fifth nerve, according to pathological and anatomical investigations of Mentzel. B. is satisfied from observations by the embryologic method that the crossing of the fourth is complete and not partial. There is no doubt that part of the third root fibres are connected with the nucleus of the other side.

The course of the second nerve is then described at length. Of Gudden's commissure it is assumed that it probably serves to give a crossed connection of the corpora geniculata interna with the lenticular nuclei.

One portion of the fibres of the tractus opticus pass to the gray substance of the third ventricle. Of the paths of the optico pupillary reflexes, nothing positive can be concluded from B.'s description.

B. then mentions the results obtained with the silver method as regards the histologic connection of the cerebral nerves with their nuclei. The root fibres of the ninth and tenth nerves, according to Held's investigations, divide into ascending and descending branches analogous to the posterior spinal roots. The descending branches form the solitary fasiculi.

The anterior root of the eighth nerve also divides into ascending and descending branches ; the last are none others than the ascending acoustic root. The first forms the remainder of the vestibular root which ends in Deiter's nucleus and the nucleus vestibularis and posterior nucleus. Similar branching takes place in the fifth nerve; the descending branch forms the so-called ascending root, the collaterals of which blend with terminal branching of the substantia gelatinosa.

In discussing the influence of the cerebellum on maintenance of equilibrium, the author says that lesion in vicinity of the third ventricle, as well as in the vicinity of the interior olive, produce entirely analogous disturbances of mobility to that produced by lesion of the semicircular canals or of the cerebellum, and further, that lesion of certain parts of the restiform bodies, the thalamus and section of the acusticus will cause loss of ability to maintain equilibrium. It is unquestionable that this statement by Bechterew tallies with clinical observations, particularly in cases of tumors, neoplasms and embolus of the mid brain, and is an important fact to keep in mind.

The fillet in the crura is divided into four portions: 1. The general fillet, which is the essential continuation of the fillet, and extends through the entire cerebral crura. 2. The lateral or inferior fillet, which lies laterally to the general fillet and reaches from the apex of the superior olive to the nucleus of the posterior corpora quadrigemina. 3. The scattered bundle thus passes forth from the base of the cerebral peduncles and penetrates nearly the entire breath of the general fillet, especially the medial portion of the latter, that is, from the level of the substantia nigra to the under portion of the pons. 4. The medial accessary bundle of the fillet passes out from the base of the peduncles of the cerebrum and lies medial to the fillet.

The divisions of the fillet are to be recognized not alone by their position and development, but also, and especially by their period of development. The lateral or inferior fillet is the first to develop, about the sixth month of fœtal life. About the full term of fœtal life the main fillet is developed, shortly after birth the scattered portions of the fillet, and last of all, the accessory bundle of the fillet.

Serial sections of the brain and spinal cord made from a thirty to thirty-five c.m. long fœtus, show that from the bundles of the funiculus cuneatus, the lateral circuit of the fillet take their course in two different directions. One set beginning at the height of the posterior corpora quadrigemina pass along the periphery of the crura cerebri, and bend posteriorly; shortly thereafter they take their course in company with the fibres of the lateral fillet found here to the corpora parabigemium, in part, while a portion sinks into the anterior corpora quadrigemiña. The other set take course farther forward; at the level of the upper portion of the red nucleus they begin gradually to bend laterally and repair to the nucleus of Luy. A portion of the fibres experience here an interruption; the greater portion, however, pass laterally and superiorly to Luy's nucleus on one side to the ansa lenticularis, and unites itself with the first and second portions of the globus pallidus, while the other side, through the mediation of Meynert's commissure, goes to the globus pallidus of the other side. Meynert's commissure serves also to give a crossed connection of the lenticular nucleus with Luy's body The connection which was formerly supposed to exist between the corpora geniculata by means of Meynert's commissure has been entirely disproven by Darkschewitsch and Pribytkow.

It is impossible to give the pathway and connections of fillet as stated by the author in greater length, except to say that the lateral fillet is considered to be the most important tract for the sensation of hearing, insomuch as the nucleus of the anterior corpora quadrigemina in which the inferior fillet is interrupted must serve as a station through which auditory excitation must pass on its way to the centre.

The pages devoted to the fillet are among the most lucid and convincing in the book, and no student of anatomy can afford to overlook them.

It is not only possible, but very probable, that the same centres in the cortex which are now associated topographically with certain functions may, through its many sided connections with the periphery of the body at one and the same time serve to perform several functions.

Certainly there have been cases observed where affection of the cortex produced disturbances of sensibility. But in these cases one finds in an overwhelming majority of the cases the lesion either beyond the borders of the motorial area, or it involves not only motor areas, but other cortical areas. Examination of the literature of such cases leads Bechterew to the conclusion that the parietal convolutions are by far the most common seat of lesion when there is disturbance of skin and muscle sensibility.

There are found in literature cases in which lesion of the lower portion of posterior cerebral convolution was accompanied by disturbances of sensation. These observations B. thinks are in accord with his observations in animals, which experiments led him to the conviction that in animals which were subjected to a destruction of the posterior and outer part of the motorial fields (corresponding to the parietal convolution in man) there followed disturbances of skin and muscle sensation in the contra-lateral extremities, and at the same time evidences of paresis of the muscles, such as are observed after lesion of the motor areas did not present. Moreover, destruction of the posterior outer portion of the gyrus sigmoides (dogs, cats) and the posterior cerebral convolutions (monkeys) which areas includes motor centres, calls forth disturbances of sensibility.

We must, therefore, conclude that the motor and sensory centres are quite independent, but they lay very close to each other, and not infrequently in a certain area they lay one over the other. In reference to the corpus collosum, the author gives nothing new. The point of exit of one portion of the fibres of the balken corresponds in the one hemisphere to the origin of the other part in the other hemisphere. From the middle of the ventricle roof the fibres of the balken go toward both sides, asunder, in the form of a fan, and cross in the inner half of the hemisphere with ascending bundles of fibres of the crura cerebri, and reach therewith the cortex of the outer and upper part of the hemispheres. A greater part of the fibres which pass out from the anterior end of the balken take their way forward in the form of a bow to both anterior lobes (forceps anterior). The fibres of the posterior end of the corpus callosum describe a similar bow-like curve on their way to the posterior segment of the hemispheres (forceps posterior). The course of fibres of the rostrum of the corpus callosum ultimately tend to the basal surface of the anterior convolutions, which Henle wished to have known as the white commissure of the base.

The so-called tapetum has been shown by new investigations not to belong to the balken as was formerly assumed, but is a continuation of the inferior half of the balken's terminal, faciculus longitudinatis inferior.

Embryologic methods corroborate the results of Monakow on the one hand and Vejas on the other, that Deiter's nucleus is in connection with the lateral tracks, especially the ground bundle of the cervical cord, and that it has no connection or relation with the anterior or posterior columns. Bechterew considers that the bundle described by Bruce as going from the inferior olive to Deiter's nucleus is but a part of the continuation between the anterior ground bundles and Deiter's nucleus which he formerly described.

With Kolliker and others, Bechterew believes that the sensory cerebral nerves spring from extra cerebral ganglia.

In reference to the ending of the optic nerve, the more recent investigations of Ramon y Cajal show that a considerable portion ends undoubtedly entirely free, with rich brush-like ramification, in the optic centre of the mid brain. Independent from this the optic nerve contains fibres which originate from the axis cylinder of cells in this centre. These fibres belong in their free endings to the retina. On the other hand, we find between the numerous terminal branches spindle-shaped cells imbedded in the mid brain, the protoplasmic branches of which everywhere come in contact with the terminal branches.

The extensive relations that the optic tract gets through contact with branches of nerve endings is stated in considerable detail.

The cells of the cerebral cortex have no continuous anatomical connection one with another, but functional relation between cells occur in the following ways: 1. Through contact of protoplasmic branches of adjoining pyramidal cells, as is the case in the multipolar cells of the anterior horns of the spinal cord. 2. Through contact of collaterals of cellular axis cylinder branches, which in greater or lesser numbers sink into a texture of fine nerve fibrillæ. 3. Through contact of end branchings of nerve fibres and collaterals of axis cylinders with protoplasm end branchings.

The book closes with a few pages devoted to a grouping together in numbered paragraphs of the principal conducting paths in the central nervous system, and to those who are prevented from carefully perusing the entire book these paragraphs are commended. They will also be serviceable to him who has given careful study to the contents of the volume, impressing, as they do, the salient points. Sixteen diagrams illustrate points discussed in the text. These diagrams, although many of them are not entirely new, are ingeniously conceived and in most instances intelligently applied. Some of them, however, need modification; for instance, one which represents a cross section of the spinal cord. As it is now, it shows fibres from the posterior root ending in cells of the posterior horns, and at the same time these cells give out fibres which pass ventrally and then leave the cord in the shape of anterior roots. Such a double function or purpose was formerly attributed to cells but newer investigations have shown that such views are no longer tenable. We must confess to a disappointment that the author has not seen fit to give drawings illustrative of anatomical conditions, in the interpretation of which he is not in accord with other investigators

We can imagine the value of the book enhanced and its usefulness more widespread if it contained such drawings. The colored plate does not call for special mention either to commend or to condemn.

In conclusion, we desire to recommend in no uncertain terms to every earnest student of neuro-anatomy this book. It is without question the most important contribution in its line that has yet emanated from the school of Flechsig. By its publication the author has fortified his reputation as an investigator and as an anatomist, and made neurologists his debtor.

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